BEFORE DEPARTMENT OF WATER RESOURCES

STATE OF IDAHO

IN THE MATTER OF THE PETITION FOR DELIVERY CALL OF A&B IRRIGATION DISTRICT FOR THE DELIVERY OF GROUND WATER AND FOR THE CREATION OF A GROUND WATER MANAGEMENT AREA	Docket No.: 37-03-11-1

DIRECT TESTIMONY OF
CHARLES M. BRENDECKE, PhD, PE

SUBMITTED ON BEHALF OF:

THE IDAHO GROUND WATER APPROPRIATOR'S INC.
NORTH SNAKE GROUND WATER DISTRICT
MAGIC VALLEY GROUND WATER DISTRICT

JULY 16, 2008

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DIRECT TESTIMONY OF CHARLES M. BRENDECKE

I. INTRODUCTION

Q STATE YOUR NAME, BUSINESS ADDRESS AND POSITION.

A My name is Charles M. Brendecke. I am employed by AMEC Earth and Environmental, Inc., 1002 Walnut Street, Suite 200, Boulder, Colorado, 80302. I am a Principal of the firm.

Q WHO ARE YOU TESTIFYING FOR?

A I am testifying as an expert witness on behalf of the Idaho Ground Water Appropriators, Inc, ("IGWA") and its members. IGWA and its members are at times collectively referred to as the "Ground Water Users." I have served as the primary technical consultant and advisor to IGWA and its members since 1999.

Q WHAT IS YOUR AREA OF EXPERTISE?

A My training is as a civil engineer specializing in hydrology and water resources. This area of study includes hydrogeology and hydrologic modeling. I have over thirty years experience in this field of work.

Q PLEASE DESCRIBE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND.

A I received a Bachelor of Science degree in Civil Engineering from the University of Colorado in 1971. I received Master of Science and Doctor of Philosophy degrees in Civil Engineering from Stanford University in 1976 and 1979, respectively. My current resume is attached at the end of my testimony.

Q HAVE YOU EVER BEEN QUALIFIED AS AN EXPERT WITNESS BEFORE?

A Yes. I have been qualified as an expert in hydrology and water rights in several Divisions of the Colorado Water Court. I have been qualified as an expert in hydrology, statistical hydrology and hydrologic modeling in interstate proceedings before the U.S. Supreme Court. I also testified as an expert on behalf of IGWA in two prior administrative hearings before Hearing Officer Gerald Schroeder. The first was in November and December of 2007 in the proceeding relating to the delivery calls by Blue Lakes Trout Farm, Inc. and Clear Springs Foods' Snake River Farm, which were consolidated for purposes of the administrative hearing. The second hearing commenced in January 2008 in the matter relating to the Surface Water Coalition delivery call.

Q DO YOU HAVE ANY PROFESSIONAL REGISTRATIONS?

A Yes. I am a registered Professional Engineer in Idaho, Wyoming, Colorado and Oklahoma.

Q WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A The purpose of my direct testimony is:

(1) to describe aspects of the hydrology and hydrogeology of the Eastern Snake Plain Aquifer (ESPA);

(2) to describe the history of development on the Eastern Snake River Plain and how that development affected the water levels in the ESPA; and

(3) to describe the effects on those water levels due to various changes in water use on the Eastern Snake River Plain.

Q CAN YOU GENERALLY DESCRIBE THE INFORMATION YOU REVIEWED AND RELIED UPON IN PREPARING YOUR TESTIMONY?

A Yes. I primarily reviewed and relied upon Orders issued by the Director of the Idaho Department of Water Resources (IDWR) and upon technical data and reports prepared by the U.S. Bureau of Reclamation (USBR), the U.S. Geological Survey (USGS) and the IDWR. I also considered and relied upon similar and related materials developed for my involvement in the earlier delivery call hearings.

Q PLEASE SUMMARIZE YOUR CONCLUSIONS:

A Based on my analysis and testimony I have reached the following conclusions:

(1) that the ESPA is not uniform but highly variable in its water conducting characteristics, and the details of these characteristics are only poorly understood;

(2) that pre-development water levels in the ESPA were substantially lower than they were when the A&B Irrigation District was developed;

(3) that prior to development of the A&B Irrigation District, water levels in the ESPA were greatly enhanced by incidental recharge by surface water irrigation development;

(4) that water right appropriation for and development of the A&B Irrigation District project occurred at a time when aquifer water levels were substantially higher than natural levels, due to the influence of incidental recharge; and

(5) that since the development of A&B Irrigation District, drought, changes in incidental recharge and ground water withdrawals have all caused water levels in the ESPA to decline.

II. THE EASTERN SNAKE PLAIN AQUIFER

Q CAN YOU GIVE US A GENERAL ORIENTATION TO THE AQUIFER AND THE ESSENTIAL FEATURES OF THE PLAIN?

A Yes. Let me do that with **Exhibit 440** which is a general map of the Eastern Snake River Plain. I've included some familiar landmarks on this map and have highlighted some essential features pertinent to this proceeding. The Eastern Snake River Plain extends from King Hill on the west to the Teton Mountains on the east. The Snake River emerges from the eastern mountains between Idaho Falls and Rexburg and flows generally southwestward along the southern edge of the plain. Milner Dam near Twin Falls is an important point; the river is often nearly dry below Milner during the irrigation season as the big canals there divert nearly all the flow in the river. Below Milner the river drops into a canyon and surface diversions for irrigation are no longer practical. Between Milner and King Hill there are numerous springs that emerge from the north side of the canyon and flow to the river. By the time the river reaches King Hill it has been substantially restored. The Eastern Snake Plain Aquifer (ESPA) underlies the broad area of the Plain between the eastern mountains and the canyon below Milner. Flow in the aquifer is generally from the northeast to the southwest. The springs in the Thousand Springs Reach are a major outlet for this ground water flow.

Q CAN YOU PROVIDE A GENERAL DESCRIPTION OF THE FORMATION AND STRUCTURE OF THE EASTERN SNAKE PLAIN AQUIFER?

A Yes. The most comprehensive and accessible description I have found of the formation of the ESPA is that contained in USGS Water Supply Paper (WSP) 774 by Harold Stearns, Lynn Crandall and Willard Steward**, an abstract** of which is attached as **Exhibit 441**. The full report is available on-line at http://pubs.er.usgs.gov/usgspubs/wsp/wsp774**.** This report, which was published in 1938, describes the geology and ground water resources of the Snake River Plain in southeastern Idaho. It covers the basic geology of the region, describing the various geological formations and then discussing the occurrence of ground water and springs.

Q PLEASE SUMMARIZE THE PERTINENT PORTIONS OF THIS REPORT RELATING TO THE FORMATION OF THE ESPA.

A According to Stearns, the ESPA is predominately basalt, the solidified remnants of ancient lava flows dating back at least to Pleistocene times, roughly half a million years ago. These lava flows are generally thought to have risen through the North American tectonic plate as it moved across the Yellowstone hot spot. Evidence of this volcanic activity abounds on the Eastern Snake River Plain, where exposed lava beds, cinder cones and buttes are common sights. The most recent lava flows, in the vicinity of Craters of the Moon National Monument, are thought to be less than 1000 years old. These lava flows occurred intermittently over a long period of time. Some flows formed smooth dense lava beds while others formed rough, broken ones. Lava flowed and solidified on the tops of earlier lava flows. In places where lava flowed over steep terrain, such as canyon rims, lava tubes were formed; these hollow structures can be tens of feet in diameter and thousands of feet long, literally forming underground tunnels. In between periods of volcanic activity other geologic processes were also at work, such as wind and water erosion and deposition, and faulting. As a result the basalts of the ESPA are discontinuous, periodically inter-layered with sedimentary or aeolian (wind-borne) materials, and riven with fractures, joints and lava tubes.

Q HOW DOES WATER ENTER THE ESPA?

A The primary sources of water input to the ESPA are precipitation on the plain, underflow from tributary basins around the edge of the plain (the disappearing Big Lost River is a good example of this), seepage from the Snake River and other streams, and seepage from irrigation canals and farm fields. The USGS estimated that in 1980 these inputs totaled a little over 8 million acre-feet per year.

Q WHAT ARE THE RELATIVE AMOUNTS OF THESE WATER INPUTS?

A The USGS estimate for 1980 showed about 63% of the input was due to incidental recharge from irrigation activities and about 37% was due to natural causes, that is, precipitation, tributary underflow and river losses. In connection with development of the new ground water model of the aquifer, modelers from the University of Idaho Water Resources Research Institute (IWRRI) estimated the incidental recharge to be about 70% and the natural recharge to be about 30% over the period 1980-2001. So the split is roughly one-third natural inputs and two-thirds irrigation-related inputs.

Q CAN YOU DESCRIBE GENERALLY HOW GROUND WATER FLOWS THROUGH THE EASTERN SNAKE PLAIN AQUIFER?

A From the standpoint of physics ground water flows downhill. Sometimes this literally means from an area of higher elevation to an area of lower elevation; this is the most common situation in the ESPA. But it can also mean from an area of higher pressure to an area of lower pressure. In either case there have to be pathways through which the water can move.

It is useful to think of the flow pathways in the ESPA at two different scales, a smaller scale where we are talking about dimensions measured in feet, and a larger scale where the relevant dimensions may be measured in miles.

Stearns describes these flow pathways in his report. According to Stearns, the most prolific and widespread of these smaller pathways are the rough, broken contacts between lava flows and the shrinkage cracks and joints that form when molten lava cools and solidifies. There are also interstitial openings in the basalt, formed by the natural inclusion of cinders or when molten lava flows are submerged in water. Then there are the lava tubes I mentioned before. Finally, there are vesicles and cavities in the basalt formed by the expansion of gases that were entrained in the liquid lava; it is these that sometimes give basalt rocks the appearance of Swiss cheese.

At the larger scale, flow pathways can have dimensions of miles. According to Stearns, the ancestral Snake River flowed more or less down the center of the Plain. Eruptions and lava flows then successively filled the river valley and canyons, blocking the river's path and forcing it to cut new valleys and canyons. Because most of the vents and volcanoes that were producing lava flows were on the northern side of the Plain, this sequence of events eventually forced the river to the southern margin of the eastern Snake River Plain where it is found today. But according to Stearns it left behind a series of buried, lava-filled canyons separated by subterranean ridges of more erosion-resistant rock. **Exhibit 442** is a depiction of this canyon-filling process from a 1936 Journal of Geology paper by Stearns. A similar depiction appears in his 1938 report.

Q DOES THE STEARNS REPORT ALSO INDICATE THERE ARE FLOW OBSTRUCTIONS?

A Yes. The Stearns report also indicates there are flow obstructions of large dimension. The most pronounced of these is an area of lava cones and fissure eruptions called the Great Rift Zone that crosses the central part of the aquifer more or less from Craters of the Moon southeast to American Falls Reservoir. **Exhibit 443**, which is reproduced from a Geological Society of America report published in 1992, provides an overview of the extent of such obstructions throughout the ESPA. The smaller flow pathways described above are interrupted by such formations, which tend to impede and redirect the movement of water and build up steep gradients (or cascades) in the ground water table. So while the ESPA is predominately one kind of rock, basalt, it is quite heterogeneous in its water carrying properties. Ground water can flow at high rates through preferential pathways and at only a trickle a short distance away. The obvious expressions of these preferential pathways are the springs that emerge from the walls of the present Snake River canyon. But the subterranean locations and characteristics of these pathways are largely unknown.

Q DO THE UNKNOWN LOCATIONS AND CHARACTERISTICS OF THESE SUBTERRANEAN FLOW PATHWAYS MAKE IT MORE DIFFICULT TO DETERMINE THE EFFECTS OF PUMPING ON WATER LEVELS IN SPECIFIC AREAS?

A Yes. Because of the variable and uncertain nature of these pathways, both the timing and location of the actual impacts of specific well pumping are difficult to predict with any degree of certainty. Unlike a flowing river where diversions and return flows can be readily seen and measured, these subsurface interconnections between wells cannot be observed. While a ground water model can shed light on general relationships over large areas, it cannot be expected to accurately predict the quantity and timing of effects of curtailment on a particular well. Of course, other things besides well pumping can also affect aquifer water levels, as I will explain later.

III. GROUND WATER LEVELS

Q WHAT WERE THE GROUND WATER LEVELS UNDER PRE-IRRIGATION-DEVELOPMENT CONDITIONS?

A There are very few data that directly document aquifer water levels prior to irrigation development, since it largely was irrigation development that triggered the drilling of wells that permitted water levels to be systematically observed. However, water level data from early wells do allow assessment of how aquifer water levels have changed over time.

Q. GENERALLY, HOW HAVE GROUND WATER LEVELS CHANGED OVER THE YEARS?

A Generally speaking, aquifer water levels increased from the early 1900s to the 1950s, as a result of irrigation development, and have declined somewhat since then. These long-term changes are not uniformly distributed across the aquifer and there are shorter-term changes due to droughts and wet spells superimposed on these general long-term trends. There are even shorter-term changes that occur within each year in response to seasonal irrigation activities. In many cases these seasonal changes in water levels are of similar magnitude as the long-term ones.

Q **CAN YOU EXPLAIN HOW WATER LEVELS HAVE INCREASED AS A RESULT OF IRRIGATION DEVELOPMENT?**

A Yes. The water levels began to rise when surface water irrigation began on the Eastern Snake River Plain in the late 1800s. Seepage losses from water conveyance and storage facilities and from farm fields caused incidental recharge that raised water levels in the aquifer beneath these irrigated areas. USGS Professional Paper (PP) 1408-C, prepared in 1995 by Luther Kjelstrom, is part of the Regional Aquifer System Analysis of the ESPA. In PP 1408-C Kjelstrom describes ground water budgets for the aquifer and water budget changes caused by irrigation development. He estimates that incidental aquifer recharge from irrigation development added 24 million acre-feet of water to storage in the aquifer between 1880 and 1952. **Exhibit 444** is reproduced from PP 1408-C. It shows how ground water storage in the ESPA changed over the period 1912-1980. **Exhibit 444** shows that aquifer storage increased steadily from 1912 to about 1950 and then declined somewhat between 1950 and 1980, though it was still substantially greater in 1980 than it was in 1912. Changes in aquifer storage are directly reflected in changes in observed water levels, so the pattern of storage change in **Exhibit 444** is indicative of changes in aquifer water levels over the same period. The Director's 2005 Orders in the delivery calls by Clear Springs Foods and Blue Lakes Trout Company recognized that incidental recharge from irrigation substantially raised ground water levels in the ESPA. The Director's January 29, 2008, Order in the present matter recognized, in Finding of Fact 18, that aquifer water levels were at their highest point in the 1950s and that, despite declines since then, they are still higher than they were under pre-development conditions.

Q **WHAT DIRECT EVIDENCE IS THERE OF THE EARLY INCREASES IN WATER LEVELS?**

A There is direct evidence of these changes in a number of USGS publications. A good overview is provided in USGS Professional Paper 1408-E, by Sally Goodell, which was published in 1988 as part of the Regional Aquifer System Analysis. Goodell describes the historical water resources development on the Snake River Plain. **Exhibits 445, 446 and 447** are reproduced from Goodell and show the historical development of surface water irrigation on the Plain. From **Exhibits 445 through 447** it can be seen that early, i.e., 19th century irrigation development on the Snake River Plain was concentrated in the upper portions of the basin, above Blackfoot. Extensive irrigation development in the central portion of the Plain, in the vicinity of Twin Falls, began in earnest in 1905 with the development of the Twin Falls Project. Diversions by the Twin Falls North Side Land & Water Company (predecessor to the North Side Canal Company) to the north side portion of the Project began in 1908. By 1915 more than 300,000 acres were being irrigated north and south of the Snake River from diversions to the Project at Milner Dam.

Exhibits 448 and 449 are also from Goodell. **Exhibit 448** shows the increase in water levels in three observation wells, the locations of which are shown on **Exhibit 449**. Water levels in observation well 8S-17E-19BBB1 reflect water levels in the aquifer beneath the area irrigated by the North Side Canal Company, a few miles west of the area of the A&B Irrigation District. It can be seen that the aquifer water level in this area rose by approximately 45 feet between 1900 and 1950 as the result of incidental recharge from surface water irrigation.

Q IS THERE EVIDENCE THAT DESCRIBES HOW IRRIGATION DEVELOPMENT AFFECTED WATER LEVELS IN THE VICINITY OF THE A&B IRRIGATION DISTRICT?

A Yes. **Exhibit 441**, the Stearns report I mentioned earlier, contains a description of the effects of the development of the North Side Minidoka Project, which lies immediately south of the A&B Irrigation District, between the District and the Snake River. Stearns noted that irrigation on the North Side Minidoka Project very quickly raised the water table in that area and that by 1910 it had been necessary to construct drains and sumps to alleviate water-logging of crop lands. According to Stearns, some surface drains were directed back to the Snake River but substantial quantities of water were disposed of to ground water in sumps and pits. Based on water level mapping done as part of his study, Stearns believed ground water from the North Side Minidoka Project flowed to the north and west, into the area that is now the A&B Irrigation District. Local ground water conditions were also investigated in connection with planning studies for the Minidoka North Side Pumping Division (now the A&B Irrigation District). In 1948, Nace et. al. produced a preliminary report on ground water conditions in Minidoka County. **Exhibit 450** is reproduced from the Nace report, and shows that between 1927 and 1948, long after surface water irrigation in surrounding areas began, ground water levels beneath A&B were still rising. Additional documentation of rising water levels is found in USGS Water Supply Paper 1654, by Mundorff, et.al., published in 1964. **Exhibit 451** is reproduced from WSP 1654 and shows early water level changes in 15 wells on the Plain. The substantial rise in aquifer water levels is clearly shown in these well records. Well 8S-25E-1cb1 is located near the town of Minidoka, at the eastern edge of what would become the A&B Irrigation District. Water levels in this well rose 190 feet between 1901 and 1959 as a result, according to Mundorff, of incidental recharge from nearby irrigation development.

Q ARE THERE OTHER STUDIES OR PUBLICATIONS THAT DOCUMENT CHANGES IN WATER LEVELS RESULTING FROM IRRIGATION DEVELOPMENT?

A Yes, there are a few more worth mentioning. In 1927 the USGS published Water Supply Paper 557, by O.E. Meinzer, which is an inventory and description of large springs in the United States, including the springs in the reach of the Snake River between Milner Dam and King Hill. **Exhibit 452**, reproduced from Meinzer, illustrates the close relationship he found between the quantity of irrigation water applied to the Eastern Snake River Plain by the North Side Canal Company, water levels in the aquifer beneath the North Side Canal service area, and the combined spring discharges at Blue Lakes and Clear Lakes springs. The incidental recharge from the North Side Canal raised water levels in the aquifer above the springs, causing spring discharge to increase.

Similar evidence of the effect of irrigation development on aquifer water levels is shown in analyses of spring discharges by Stearns and by Mundorff in their respective USGS reports. Stearns report that I mentioned earlier shows that between 1902 and 1917, incidental recharge from diversions of the the North Side

Canal Company caused the flow of Blue Lakes spring to rise from 80 cubic feet per second (cfs) to 110 cfs, the flow of Crystal Springs to rise from 304 cfs to 536 cfs, and the flow of Clear Lakes spring to rise from 150 cfs to 538 cfs. **Exhibit 453** is reproduced from the Mundorff report and shows the increase in discharges of Blue Lakes, Crystal, Niagara and Clear Lakes springs following irrigation development under the North Side Canal.

Q YOU MENTIONED EARLIER THAT WATER LEVELS INCREASED UNTIL ABOUT THE 1950S IS THAT TRUE?

A Yes. Water levels generally increased for the reasons I have described above until about the 1950s when they leveled off. Since then they have declined somewhat though, as noted by the Director in his January 29, 2008, Order at Finding of Fact 18, they are still higher than they were under pre-development conditions. So the peak water level condition in the aquifer likely occurred in the 1950s.

Q DO YOU HAVE AN OPINION AS TO HOW MUCH OF THIS PEAK WATER LEVEL CONDITION WAS NATURAL IN ORIGIN AND HOW MUCH WAS THE RESULT OF INCIDENTAL RECHARGE FROM SURFACE WATER IRRIGATION?

A If one accepts the premise that natural recharge in the years leading up to the 1950s was not materially different from natural recharge under pre-development conditions, I would have to conclude that the elevated water levels were entirely the result of incidental recharge.

IV. CHANGED IRRIGATION PRACTICES

Q SO HAVE WATER LEVELS REMAINED AT THE ARTIFICIALLY ENHANCED LEVEL THEY EXHIBITED IN 1950?

A No, they have not. They have declined somewhat from this peak level.

Q AND WHY HAVE THEY DECLINED IN YOUR OPINION?

A Starting in the 1950s and early 1960s, changes in surface water irrigation practices began to diminish the amount of incidental recharge to the ESPA. Principal among these changes in irrigation practice were the conversion from flood irrigation to sprinklers and the cessation of winter diversions in connection with the Palisades Reservoir project.

Q HOW DID THE CONVERSION TO SPRINKLERS AFFECT INCIDENTAL RECHARGE?

A Sprinklers are generally a more efficient irrigation water application method than flood and furrow, or "gravity" application methods. By that I mean sprinklers can supply crop water requirements with smaller incidental losses than can flood and furrow methods. One of the principal water losses in flood and furrow irrigation is deep percolation. This is water that seeps down past the crop root zone to the ground water table.

Prior to the 1950s flood and furrow irrigation was the primary method of water application on the Eastern Snake River Plain, hence all the incidental aquifer recharge I have discussed earlier. In PP 1408-C, Kjelstrom notes that by the 1970s about 20 percent of surface water irrigation distribution systems had converted from gravity application methods to sprinkler application methods and that this conversion reduced deep percolation to the aquifer.

In 1981 the University of Idaho published (Hamilton, et al., 1981) the results of a survey of the responses of irrigators to the severe drought of 1977. **Exhibit 454** is reproduced from the Hamilton report. It shows that the survey found that many irrigators in counties on the Eastern Snake River Plain had installed sprinkler systems, had added gated pipe, and had lined ditches as a result of the 1977 drought. All of these measures could be expected to reduce incidental recharge to the ESPA by reducing seepage and deep percolation.

The Director acknowledged these trends toward increased application efficiencies in his January 29, 2008, Order at Finding of Fact 42, where he notes declines in surface water diversions of more than one million acre-feet per year since 1980.

Q WHAT WAS THE PALISADES RESERVOIR PROJECT AND HOW DID IT AFFECT INCIDENTAL RECHARGE?

A The principal purpose of the Palisades Reservoir Project was to increase the storage water supplies for surface water users on the eastern Snake River Plain. In October of 1946, the U.S. Bureau of Reclamation (USBR) published a planning report for the Palisades Reservoir Project. In its submittal of the report to the Secretary of the Interior, the Commissioner of Reclamation stated that the full benefit of the Project could only be realized if surface water users would enter into agreements to stop "wasteful non-irrigation season diversions" thereby saving 435,000 acre-feet of water for storage in the Project. Winter Water Savings agreements were subsequently negotiated with many canal companies that divert from the Snake River, including the North Side Canal Company.

Q HOW WOULD THE PALISADES WATER SAVINGS AGREEMENTS AFFECT AQUIFER WATER LEVELS?

A They would affect water levels by reducing non-irrigation season recharge of the aquifer. The Palisades Winter Water Savings agreements went into operation in 1961 and generally required participating canal companies to cease diversions in the months of November through March. **Exhibit 455** is derived from records of the USGS and the IDWR and shows the historical November through March diversions of the North Side Canal Company. The onset of the Winter Water Savings Program is clearly evident in this diversion record. Irrigation requirements on the Eastern Snake River Plain are negligible in the months of November through March. Other than minor amounts of consumption for domestic and livestock uses, it is reasonable to assume that nearly all of the historical winter diversions of the North Side Canal Company (and of the other canal companies participating in the program) contributed to incidental recharge of the ESPA. Based on **Exhibit 455**, the Winter Water Savings of the North Side Canal Company alone may have reduced incidental recharge to the ESPA by roughly 150,000 acre-feet per year. The winter diversion reductions of just five canals (North Side, Anderson, Great Western/Porter, Idaho, and Twin Falls) came to approximately 370,000 acre-feet per year.

So reducing or eliminating winter diversions under the Winter Water Savings agreements had the effect of substantially reducing wintertime incidental recharge to the ESPA.

Q HOW WOULD THIS REDUCED INCIDENTAL RECHARGE AFFECT WATER LEVELS ELSEWHERE IN THE AQUIFER, SUCH AS BENEATH THE A&B IRRIGATION DISTRICT?

A Just as the influence of well pumping is propagated outward into the aquifer in all directions, so is the influence of recharge propagated outward. So even though winter diversions were eliminated mainly by the canals signing agreements, the effect of this reduced recharge was distributed into broad areas of the aquifer.

Q WHAT WERE THE EFFECTS OF THESE CHANGED IRRIGATION PRACTICES ON WATER LEVELS?

A These changes reduced incidental recharge to the ESPA thus reducing storage in the aquifer. This reduced storage is reflected in lower water levels.

Q YOU ALSO MENTIONED THAT DROUGHT CYCLES AFFECT AQUIFER WATER LEVELS. CAN YOU DESCRIBE THESE EFFECTS?

A Yes. During drought there is less recharge to the aquifer. Natural precipitation on the Plain is reduced so less of that becomes recharge. Irrigators often adopt more efficient practices during drought so as to make their smaller water supplies go further; this reduces incidental recharge to the aquifer. The effects of drought on aquifer water levels were documented in conjunction with development by the IDWR of the new ground water model of the ESPA. **Exhibit 456** shows the close relationship between precipitation at the Aberdeen weather station and aquifer recharge estimated for the model calibration period from 1980-2002. Declines in aquifer recharge follow, in an only slightly delayed fashion, declines in precipitation associated with drought cycles. **Exhibit 457** shows observed changes in observed aquifer water levels across the ESPA between 1980-2001 and 2001-2002. The 1980 measurements were made as part of the USGS RASA study. The 2001 and 2002 measurements were made as part of the model development work. It is noteworthy that between 1980 and 2001 water levels changed only slightly, and in some areas increased. Between 2001 and 2002, with the onset of the recent severe drought, water levels declined across the ESPA in just a single year. This clearly demonstrates how responsive aquifer water levels are to drought conditions.

Q HAS ANYTHING ELSE AFFECTED WATER LEVELS ON THE ESPA GENERALLY?

A Yes. Ground water pumping has withdrawn some of the storage added to the aquifer by early irrigation development. This has reduced ground water levels in some areas.

Q WHEN DID GROUND WATER DEVELOPMENT BEGIN ON THE ESPA?

A According to Goodell, ground water development for irrigation began in the Mud Lake area in the 1920s with shallow wells. But significant ground water development didn't really get underway until after World War II with improvements in pump technology and the availability of electric power. The first wells in the "B unit" of the North Side Pumping Division (as A&B was called at the time it was operated by the USBR) began operating in 1949. Most ground water development on the Eastern Snake River Plain occurred between about 1950 and 1985. **Exhibit 458** is derived from the Goodell report, and shows the status of irrigation development in 1966, distinguishing surface water-supplied lands from ground water-supplied lands. Ground water development since 1966 has occurred in the same general areas as shown on **Exhibit 458**. There has been a moratorium in this area prohibiting new ground water withdrawals for irrigation since 1992.

Q WHAT WAS THE MOTIVATION FOR THIS GROUND WATER DEVELOPMENT?

A I expect there were many motivations on the part of individuals. In general I would say two factors were instrumental. First, land and improved pumping technology were available at reasonable cost. Second, the State of Idaho promoted ground water development through adoption of legislation and state water plans and through issuance of ground water rights. Idaho Power Company also offered discounted electric power service to irrigation pumpers and actively promoted ground water development. **Exhibit 459** is a brochure distributed by the power company in the 1960s encouraging Idaho "to do everything possible to encourage expansion of irrigation pumping."

I would also note that because they generally allow better water distribution with lower labor cost, sprinkler systems, often supplied by ground water, were adopted by many surface water users. Based on information generated during the development of the new ground water model, it appears that there are several hundred thousand acres of land on the Eastern Snake River Plain with both surface and ground water rights.

Q IS THERE ANY ADMINISTRATIVE DIFFICULTY IN PROPOSING TO CURTAIL JUNIOR GROUND WATER RIGHTS TO RAISE WATER LEVELS THAT ARE BELOW A & B IRRIGATION DISTRICT?

Yes, there are several. First, because of the heterogeneous nature of the aquifer the effects of curtailing junior rights in some locations will have greater or lesser effects than curtailment of junior rights in other locations. Curtailment of some junior rights may well have little or no effect on water levels beneath A&B.

While the IDWR ground water model can shed some light on broad regional effects of pumping curtailment, it really can't simulate local-scale effects, particularly in areas with complex hydrogeology such as the A&B area.

It will also take an extended period of time to determine the effectiveness of curtailment, simply because water levels beneath A&B will not respond instantly to cessation of pumping at distant locations. The benefits of curtailment are dispersed; a considerable proportion of the foregone pumping will be reflected in storage increases in other areas of the Plain than A&B. All these factors suggest to me that widespread curtailment of junior ground water rights would not be a very effective way, from a resource management perspective, to improve water levels beneath A&B.

Q IS IT POSSIBLE TO RESTORE THE ARTIFICALLY HIGH WATER LEVELS OF THE EARLY 1950s?

A No. It is my opinion that the peak water levels in the early 1950s can never be restored, absent the return of pre-1950 conditions which would require the elimination of sprinkler irrigation in favor of flood irrigation across the ESPA and the elimination of winter storage in Palisades Reservoir. That said, it is reasonable to expect water levels to stabilize near present levels as the effects of drought ease and the effects of the irrigation well moratorium reach equilibrium. Some incidental recharge will continue, even with conversions to sprinklers.